ROYAL PORTRUSH GOLF CLUB

Further Assessment of Coastal Protection Options – Marine Licence Application, Curran Strand, Portrush

IBE0947
D04
01 Sept 2022

Document status

Version	Purpose of document	Authored by	Reviewed by	Approved by	Review date
D01	Initial Review	KC			
D02	Client Review	KC	CS	AKB	27/07/2022
D03	Final Issue	KC	CS	AKB	15/08/2022
D04	Final Issue	KC	CS	AKB	01/09/2022

Approval for issue

Adrian Bell	Adrian x. Bell	01st September 2022

Prepared by:

RPS

Kristopher Calder BSc (Hons) MSc C.Sci MCIWEM C.WEM AMICE
Senior Associate - Water Environment and Flood Risk Management

Elmwood House
74 Boucher Road, Belfast
Co. Antrim BT12 6RZ

T +44 2890 667 914
E kristopher.calder@rpsgroup.com

Prepared for:

Royal Portrush Golf Club

John Lawler
General Manager

Dunluce Road,
Portrush
BT56 8JQ

T +44 (0) 28 7082 2311
E

Contents

Tables

Figures

1 INTRODUCTION

In 2016, Royal Portrush Golf Club (RPGC) commissioned RPS to undertake a coastal erosion study of the Curran Strand at Portrush. This appointment was in response to a series of high-energy storm events that impacted the north coast in early 2014 and resulted in extensive erosion of the beach, including at the toe of the iconic 6th tee of the Dunluce Links Championship course.

This study found that without additional protection works, terminal erosion at the existing rock armour defence could result in the coastline retreating by *c.*6.0m during a 1 in 100 year return period scenario. Whilst coastal erosion is an important natural process that plays a fundamental role in redistributing sediment in a coastal system, it was recognised that erosion at the 6th is exacerbated by the poorly designed abrupt termination of the existing rock armour defence.

Whilst rock armour has long been used to mitigate erosion, understanding the governing processes of terminal erosion and the development of measures to mitigate this process have advanced significantly in recent decades. Having successfully designed several retrospective schemes to mitigate terminal erosion, RPS recognised that the most sustainable solution to limit future erosion at the 6th was to design a scheme that properly terminated the existing defence.

Through an extensive numerical modelling programme, RPS developed a modest 20m taper structure that could be constructed at the western extent of the existing 90m revetment structure. This proposal effectively mitigated the irreversible damage of coastal erosion and associated coastal retreat at the 6th tee. Importantly, this robust assessment found that the proposed development did not result in a significant adverse impact on the adjacent undefended coastline, with the overall impact of the proposal on existing coastal processes considered *de minimis*.

To support the Planning Application required for this proposed development, an Environmental Statement (ES) (including shadow Habitats Regulations Assessment) was prepared and submitted in February 2019 in accordance with the framework provided by the Planning (Environmental Impact Assessment) Regulations (Northern Ireland) 2017.

The planning application (LA01/2017/0539/F) was subsequently determined by Causeway Coast and Glens Borough Council (CCGBC) who granted planning approval for a proposed 20 metre rock revetment taper to existing rock armour, sand trap fencing and planting at lands at Curran Strand, Portrush on 13th May 2021 (*with conditions*).

A subsequent section 54 application was submitted to CCGBC to vary the wording of conditions 9 and 12 of the LA01/2017/0539/F permission to ensure that monitoring on the beach post implementation and construction of the approved LA01/2017/0539/F rock armour is undertaken consistent with industry standards and applicable guidance.

The principal change sought to the conditions is to reduce the frequency of beach monitoring surveys post-construction, consistent with prevalent industry guidance, to a biannual frequency rather than monthly and within two weeks of a storm event. This application has since been accepted.

In March 2022, Clyde Shanks on behalf of RPGC engaged with the Department of Agriculture, Environment and Rural Affairs (DAERA) Marine Licensing Team as part of a pre-application engagement to discuss the contents of a Marine Licence application to give effect to planning permission LA01/2017/0539/F as subsequently superseded by LA01/2021/0822/F and approved 08th August 2022.

During this process, the Department expressed its desire for modelling to be extended to assess the potential option where the existing 90m defence was modified and reduced to include a tapering structure. These concerns regarding the lack of numerical assessment of this alternative option was previously raised in consultation dated 23rd September 2019. The Environmental Statement had previously ruled this option out as part of the alternatives studies section.

Notwithstanding that planning permission has been secured for the 20-metre taper proposed as part of LA01/2021/0822/F, and was the subject of a comprehensive EIA process, Royal Portrush Golf Club has voluntarily commissioned RPS to undertake additional modelling in response to a recommendation made by DAERA.

This report specifically addresses the points raised by DAERA and has been informed by ongoing work in progress on coastal erosion management guidance being prepared by the R&A for links courses across the UK. This has included a discussion with Royal Haskoning and R&A officials and an understanding of the guidance being prepared to assist links courses to manage coastal change through the preparation of Coastal Change Management Plans.

It is however important to note that this body of work is non-statutory, draft guidance and that there are very different circumstances that apply to a wide range of locations across the UK.

2 BACKGROUND

2.1 Existing Coastal Erosion Risk

Informed by an extensive numerical modelling programme, a previous assessment of coastal processes along the Curran Strand (RPS 2018) found that a 1 in 100 year return period storm event[1] could result in a localised retreat of the dune crest of c. 6m in the area of the 6th tee. Under this scenario, approximately 110m^2 of the globally renowned Dunluce Championship course could be lost to coastal erosion as illustrated in Figure 7.9, even with the existing 90m rock revetment in place.

The sudden and abrupt termination of the existing rock armour revetment was found to be the principal reason that the Club continue to observe accelerated coastal erosion at the 6th tee.

Whilst the magnitude of erosion associated with this event is not considered to be significant in the context of the overall sediment transport regime, it would result in irreversible damage to a globally important tourism asset which conveyed iconic images of Northern Ireland to a global television audience during the staging of the 148th Open Championship at Royal Portrush Golf Club in July 2019. For context, this was the biggest sporting event ever held in Northern Ireland with independent research confirming that the event produced:

- A total economic benefit for Northern Ireland of £106M;
- A destination marketing benefit of £61M; and
- An economic impact for the Causeway Coast & Glens Council of £26.2M.

Furthermore, as the global climate continues to change into the future, increasing sea levels are expected to enhance coastal pressure owing to larger waves being able to propagate closer inshore. Under these future climate conditions, extreme storm events are highly likely to become more frequent and increase the risk of coastal erosion and retreat along vulnerable soft coastlines like that at the Curran Strand.

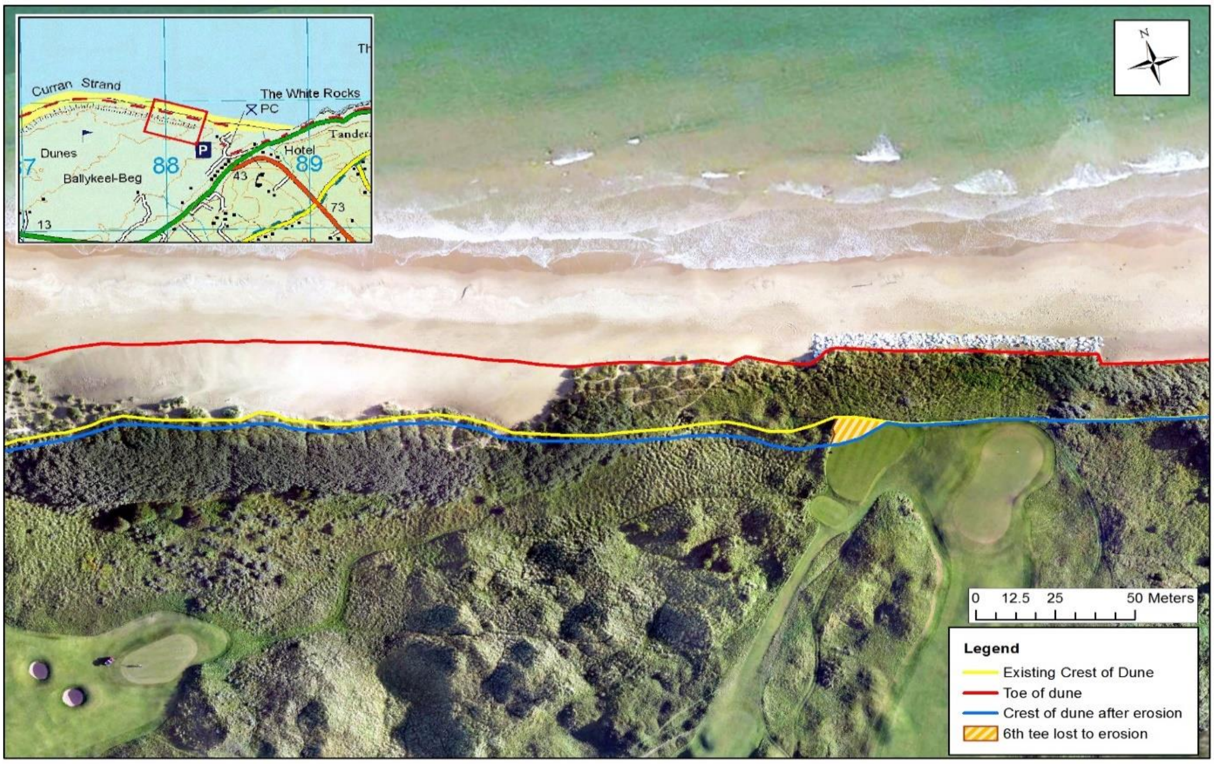


Figure 2.1: Area of the 6th tee that could be lost to coastal erosion under 1 in 100 year event from NW with the existing hard defences in place.

[1] A 1 in 100 year return period storm event has a 1% chance of occurring in any one year and a 40% chance of this event occurring within a 50 year period.

3 OPTIONS APPRAISAL

The Environmental Statement that formed part of the planning application submission in February 2019 was the subject of a comprehensive consideration of alternatives chapter in addition to a detailed coastal modelling chapter. The outworking of that was to demonstrate that the most sustainable option to mitigate the risk of coastal erosion to the 6th tee is to construct a 20m tapering extension to properly terminate the existing 90m rock revetment.

The findings of this report therefore satisfy statutory requirements as set out in Schedule 4 of The EIA (Northern Ireland) Regulations 2017 which requires an ES to include:

'A description of the reasonable alternatives (for example in terms of development design, technology, location, size and scale) studied by the applicant which are relevant to the proposed development and its specific characteristics, and an indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects.

Notwithstanding the extant planning permission that has been secured and following the meeting with DAERA Marine and Licensing team in March 2022 RPCG voluntarily commissioned RPS to undertake additional modelling in order to address the points raised by the Department.

Accordingly, RPS has adopted the following optioneering process for this further assessment as summarised in Figure 3.1 below.

Figure 3.1: Summary of optioneering process

The starting point in the optioneering process is to review the coastal erosion risk in the study area. The risk receptors, in this instance the 6th tee, are then assessed to ascertain where risk management measures will be required and to what extent. The assessment is based on the coastal erosion risk summarised in Section 2.1 and described in detail in the Environmental Statement as part of planning permission LA01/2021/0822/F (RPS 2018).

Having quantified the coastal risk, high-level coastal management policies are screened to rule out those considered non-runners. The individual management measures that comprise the remaining high-level policies are then used to develop a long list of potential management options (see Section 3.3). This long list of options is then appraised to rule out options that are unreasonable *(in terms of development design, technology, location, size and or scale).*

The shortlist of feasible options can then be considered in greater detail using either a qualitative or quantitative assessment.

3.1 Plan Objectives

Before proceeding with the optioneering process it is important to define the objectives of a coastal management plan. Whilst there is no relevant specific guidance for coastal management in Northern Ireland, RPS have referred to equivalent guidance in England and Ireland, specifically:

- The latest Flood and Coastal Erosion Risk Management Appraisal Guidance (FCERM) issued by the Environment Agency (Environment Agency 2020).
- Guidance notes issued by the OPW as part of the Catchment Flood Risk Assessment Study.

Both guidance documents recommend establishing an appraisal period when considering coastal management options. In this respect, a 100-year period is most commonly used so that long-term climate change impacts and sustainability can be considered over the life span of a management solution. Acknowledging coastal pressures changing in the future, these documents also recommend considering options over different short, medium and long-term epochs during this 100-year period. This assessment has utilised the epochs summarised in Table 3.1.

Table 3.1: Summary of coastal management epochs considered for this study

Epoch	Short Term	Medium Term	Long Term
Time frame	Present day to + 20yrs	+20yrs to +50yrs	+50yrs to +100yrs

The primary objectives of a coastal management plan for the Curran Strand are to:

1. Successfully reduce the impact of the existing coastal defence by reducing terminal erosion at the end of the existing structure and thus decrease the threat of coastal erosion in the localised area of the iconic 6th tee.
2. Avoid negatively impacting the existing coastal processes by installing any form of shore protection that would interfere with key coastal processes beyond the immediate vicinity of the 6th tee.
3. Improve resilience to coastal change in a way that can adapt to meet a range of future climate change scenarios when needed
4. Maintain and ensure the future resilience of the globally renowned and unique tourism asset offered by the Dunluce Championship course

Other relevant Critical Success Factors (CSF) for a scheme as set out in the HM Treasury Green Book used for appraisal and evaluation (HM Treasury 2013) include ensuring:

- **Potential value for money** - the whole life benefits of the option should exceed costs and provide good value when compared to alternative options and other coastal management investments.
- **Supplier capacity and capability** - potential suppliers must have the capacity to carry out the option.
- **Potential affordability** – the option can be funded within the funding policies of contributing partners
- **Potential achievability** – it is possible to get necessary approvals and consents and it must be physically possible to construct and maintain the option over its intended life

3.2 Screening of High-Level Polices

Having established the appraisal period, primary objectives and Critical Success Factors of a coastal management plan, RPS undertook an initial screening process to review the technical feasibility and economic justification of all high-level coastal management policies. These generic policies and an initial review of each is presented in Table 3.2 overleaf.

At this stage, the policies of “No Active Intervention” and “Advance the line” were ruled out as they did not meet the primary objectives of the coastal management plan as described in Section 3.1 .

All other policies and the corresponding long list of options were subsequently described and appraised in Section 3.3.

Table 3.2: Initial review of coastal management policies

Policy	Policy Description	Initial Review	Brought Forward?
No Active Intervention (NAI)	This is a policy decision not to invest in the provision or maintenance of coastal management measures. This policy maintains coastal processes on undefended coastlines and enables the shoreline to evolve naturally. In areas that are defended, this policy involves walking away and ceasing all maintenance & repair of existing defences.	Under this policy option, the existing 90m rock armour revetment would continue to provide effective but limited protection to the 6th Tee of the Dunluce Championship course. But as the existing revetment lacks proper termination detail, the adjacent undefended dune will continue to be outflanked by incident waves. As described in Section 2.1, under extreme storm conditions, this increased scouring and accelerated terminal erosion could result in the partial but irreversible loss of one of the foremost tourism assets in Northern Ireland. This option is not considered feasible as it does not meet the primary objectives of the coastal management plan as described in Section 3.1. It has therefore been screened out from further assessment.	✗
Advance the Line	This policy involves building new defences on the seaward side of the original defences to reclaim land and often improve the standard of protection provided by the original defences	This policy is most commonly associated with land reclamation schemes such as Port or harbour developments. Advancing the position of the coastline seaward is not a primary objective of the coastal management plan as described in Section 3.1 and has therefore been screened out from further assessment.	✗
Hold the Line	This policy involves improving or maintaining the standard of protection provided by the existing defence line. Renewed defences refer to the construction of new, more robust defences. There may be some residual risk in holding the line such as a steepening of the foreshore or the loss of beach width. Such factors could make this policy unsustainable sooner than anticipated. This policy aims to retain the existing character and form of the coast with minimal disruption, whilst maintaining all existing assets.	This policy should be considered further as it potentially achieves many of the primary objectives and critical success factors described in Section 3.1.	✓
Managed Realignment	When a coastline is protected with hard or soft defences, this option involves allowing the coastline to move backwards (or forwards) by realigning the position of existing defences and creating a new line of protection. In terms of coastal erosion, this policy can involve establishing a sacrificial buffer zone where no development is permitted (i.e., a no-build zone). For coastal flooding, it will state a minimum elevation above mean sea level for development.	At the Curran Strand, this policy would involve realigning the existing rock armour revetment and adjacent rock-filled gabion baskets. This is not considered a feasible policy over the short term to medium term as it would be necessary to undertake extensive planning with course architects and the R&A to develop, approve, finance and construct a new course layout in such a short period of time. However, the feasibility of this option increases significantly over the longer team owing to the increased coastal pressures stemming from future climate change, particularly rising sea levels and change in storm patterns. This option should not be screened out at this stage.	✓
Managed Retreat	This policy is applicable when a coastline is not protected by coastal defences. Similar to the policy of Managed Realignment, this policy involves establishing a sacrificial buffer zone whereby no further development is permitted (i.e., a no-build zone).	Similar to Managed Retreat, this policy would involve allowing the rest of the Curran Strand which is currently undefended to evolve naturally and respond to future climate change. As before, this policy is not considered feasible over the short term to medium term as it would be necessary to undertake extensive planning with course architects and the Royal and Ancient to develop, approve, finance and construct a new course layout in such a short period of time. However, the feasibility of this option increases significantly over the longer team owing to the increased coastal pressures stemming from future climate change, particularly rising sea levels and change in storm patterns. This option should not be screened out at this stage.	✓

3.3 List of Options and Appraisal Criteria

Each high level coastal management policy described in the previous Section is comprised of several different options that could mitigate the risk of coastal erosion. A summary of potential management options and the applicability of each in respect of common coastal pressures are summarised in Table 3.3.

Table 3.3: The suitability of coastal management options for different coastal pressures

CFERM Option	Coastal Pressure			Construction Type
	Tidal Flooding	Wave Overtopping	Erosion	Hard/Soft/Mixed
Seawalls	✓	✓	✓	Hard
Revetments		▲	✓	Hard
Embankments	✓	▲		Hard
Maintenance	▲	▲	▲	Mixed
Groynes		▲	✓	Mixed
Detached breakwaters		▲	✓	Mixed
Headlands		▲	✓	Mixed
Dune stabilisation (soft engineering)	✓	▲	✓	Soft
Beach Nourishment	▲	▲	✓	Soft
Managed realignment	✓	✓	✓	Soft
Managed Retreat	▲	▲	▲	Soft
Do nothing	▲	▲	▲	Soft

Key	
Applicable	✓
Applicable in some cases	▲
Not applicable	

An initial appraisal of each option is presented in the following sections of this report and summarised in Table 3.3.

3.3.1 Hold the Line

3.3.1.1 Seawalls

Description

Seawalls protect banks and bluffs by completely separating land from water. Seawalls are primarily used to resist wave action and if designed correctly can provide effective protection to the hinterland. However, seawalls do not protect the shore in front of them. On the contrary, erosion of the seabed immediately in front of the structure will in most cases be enhanced due to increased wave reflection caused by the seawall. This usually results in a steeper seabed profile which in turn allows larger waves to reach the structure.

A seawall is usually a fixed, inflexible structure. Future sea level rise must be accounted for during the design phase. A typical sectional view of a seawall is presented in Figure 3.2 below.

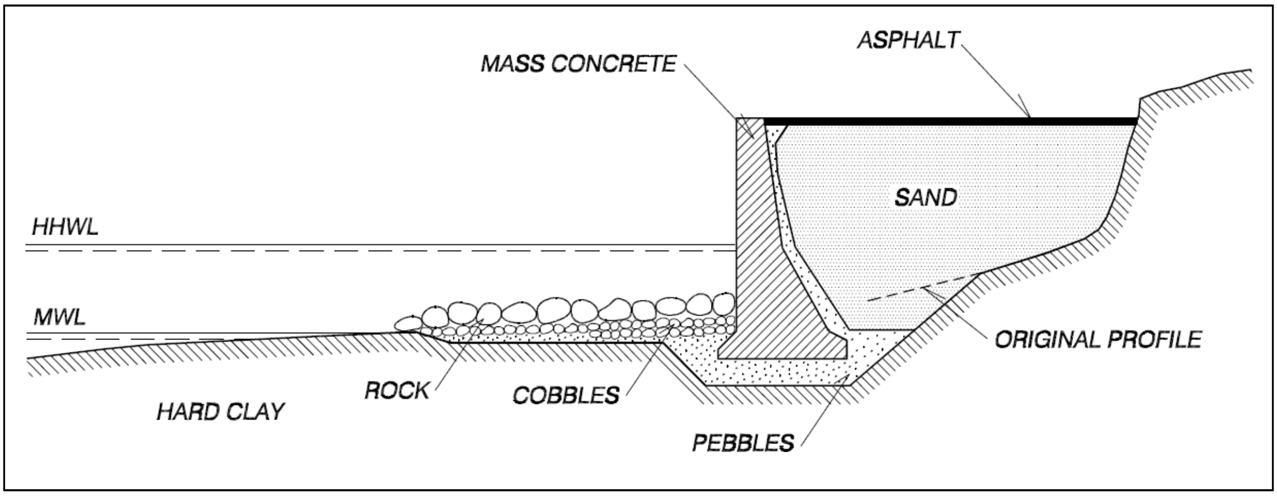


Figure 3.2: Typical section view of a vertical seawall (USACE U.S. Army Corps of Engineers 2006)

Initial Appraisal

In exposed and energetic environments, seawalls can contribute to beach drawdown, coastal squeeze and terminal erosion. However, in suitable environmental conditions with low wave energy and relatively stable foreshores, seawalls can offer a very effective solution to mitigate flood risk and limited coastal retreat during extreme events. In these instances, there is only a limited potential for seawall defences to negatively impact environmentally sensitive areas.

From a social perspective, seawalls are very effective at preventing coastal erosion and other damage due to wave action and storm surges, such as flooding. But as described previously, these structures can result in beach squeeze and contribute to the loss of an important amenity.

This option involves relatively high initial capital and ongoing maintenance costs. However, these costs are often justified subject to the projected magnitude of risk in a given area.

Feasibility

This option should not be considered further for the following reasons:

- Other options provide equivalent protection with less impact on the natural environment.
- Significant technical challenges associated with constructing a concrete seawall in a marine/beach environment.
- This option is very difficult to adapt to future climate conditions
- The reflective nature of this option would increase erosion on adjacent soft coastlines.

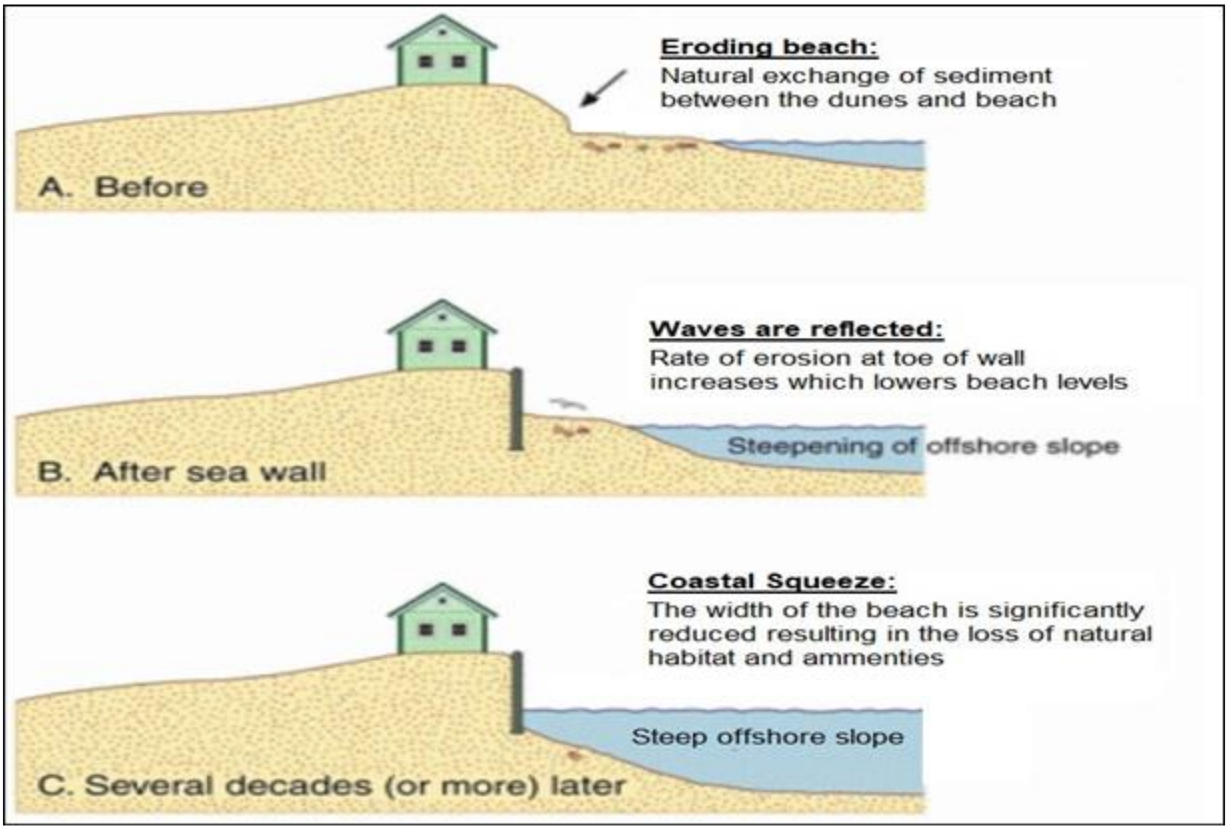


Figure 3.3: The long-term impact of a seawall (Cooper and Pilkey 2004)

3.3.1.2 Revetment or modified revetment

Description

Revetments are shore parallel sloping defences that dissipate wave energy. Some modern revetments have concrete blocks laid on top of a layer of finer material while rock armour or riprap revetments consist of layers of very hard rock often weighing several tonnes. Riprap has the advantage of good permeability and looks more natural.

A revetment is more flexible than a seawall and is therefore easier to modify in response to future climate change. Although revetments can reduce flood risk by reducing wave overtopping, they do not generally prevent flooding due to tidal inundation.

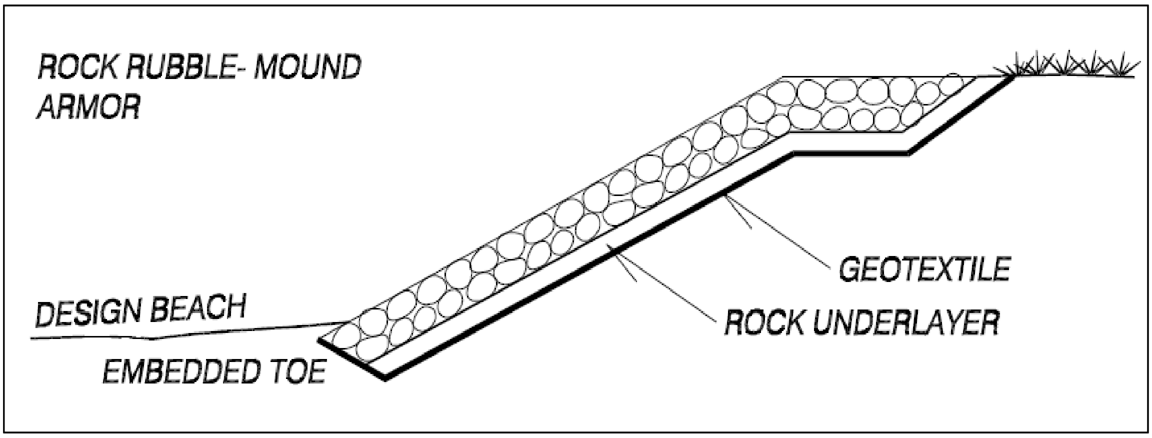


Figure 3.4: Typical section view of a rubble mound revetment (USACE U.S. Army Corps of Engineers 2006)

As is the issue with the existing revetment, if these structures come to an abrupt termination without a well-designed taper, these structures can deflect wave energy and accelerate erosion on adjacent soft coastlines. An example of terminal erosion at Wicklow is presented in Figure 3.5.

However, this accelerated erosion can be mitigated through the construction of a well-designed taper structure which creates a transition zone to provide a more natural, gradual transition from the hard rock armour to the soft, erodible coastline. Figure 3.6 below illustrates the tapering revetment structure designed by RPS on behalf of Wicklow County Council in *c.*2016. As reported by Wicklow County Council, this modification was very effective in arresting virtually all terminal erosion during subsequent extreme storm events, including Storm Emma in 2018.

Figure 3.5: Example of terminal erosion at the Murroughs, Wicklow (*c.*2014)

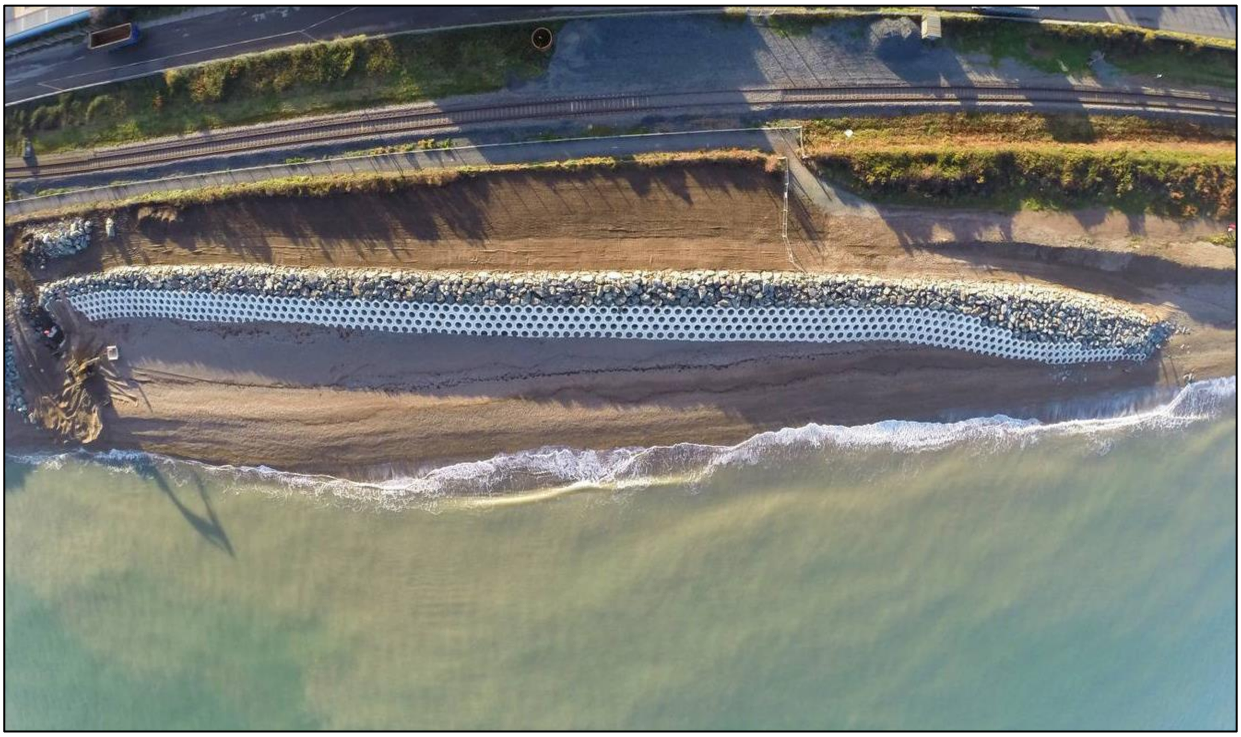


Figure 3.6: Example of tapering revetment structure used to mitigate terminal erosion at the Murroughs, Wicklow (*c.*2016)

Initial Appraisal

The existing 90m revetment along the Curran Strand has, since installation in 1983, provided very effective protection against extreme storm events. Importantly, since this defence was installed, there have been no records of beach squeeze or negative impact to the wider sediment transport regime. However, owing to the abrupt termination of this defence there is a modest degree of terminal erosion evident at the western flank of the existing defence.

From a technical perspective, it is well established based on evidence from sites like the Murroughs at Wicklow that modifying an existing rock revetment to include a tapering section can effectively reduce terminal erosion.

Whilst it is recognised that traditional revetment structures can interrupt the release of sediment stored in a dune to the foreshore, the lack of beach squeeze or wider environmental impacts stemming from the construction of the existing revetment demonstrates the sediment transport regime is not governed by the exchange of sediment at the 6th tee.

From a social perspective, a tapering revetment structure would maintain and ensure the future resilience of the unique and globally renowned tourism asset offered by the Dunluce Championship course.

In respect of economics, the initial capital and ongoing maintenance costs of a rock armour revetment are usually cheaper relative to seawalls.

Feasibility

This option should be considered further for the following reasons:

- An existing 90m rock armour revetment has provided effective, but spatially limited, protection to the 6th tee with no evidence of any adverse impact to the wider sediment transport regime since it was first installed in the early 1980s.
- RPS have experience of designed tapering revetments that have effectively reduced terminal erosion
- From a technical perspective, constructing a rock armour revetment is relatively simple compared to other coastal defences.
- Modifying an existing defence would be more cost-effective than most other coastal defence options.
- Rock armour can be easily modified, removed or adapted in response to climate change or different coastal pressures.
- In the context of protecting the nationally important tourism asset of the Dunluce Championship links, modifying the existing rock armour revetment would represent exceptionally good value for money.

3.3.1.3 Groynes

Description

Groynes are narrow structures that are usually constructed perpendicular to the shoreline. A single groyne promotes the accretion of beach material on the updrift side but erosion on the downdrift side; both effects extend some distance from the structure. Consequently, a groyne system can result in a saw-tooth-shaped shoreline with different beach levels on either side of the groynes.

Groynes create very complex current and wave patterns. However, a well-designed groyne system can slow down the rate of longshore transport and by building up material in the groyne bays, provide some protection of the coastline against erosion.

In most cases groynes are rubble mound constructions, however, timber or sheet piling can also be used as illustrated in Figure 3.7. Rock armour is generally the preferred option because of the rubble mounds' ability to withstand severe wave loads and decrease wave reflections.

Initial Appraisal

As described in the previous report (RPS 2018), the sediment transport regime at the Curran Strand is governed by longshore and cross-shore transport processes. Given the significant cross-shore processes which are most obvious following storm events when sediment is stripped from the upper beach to form a nearshore bar popular with local surfers, it is clear that a groyne option is a wrong solution for this beach.

From a social perspective, groyne structures represent a significant obstacle to users of the beach amenity. This is particularly true for beaches like the Curran Strand whereby the tide can encroach right up to the toe of the dune.

Figure 3.7: Example of wooden groynes at Bognor Regis

Feasibility

This option should not be considered further for the following reasons:

- The nature of the sediment transport processes along the Curran Strand means that a groyne solution is unlikely to successfully trap sediment material.
- A groyne solution would introduce significant obstacles along the beach which could create significant health and safety issues for beach users during periods of high tide.
- The whole life cost of a groyne solution would be significantly greater than other alternative options.
- A groyne solution would have a much greater impact on existing coastal processes by blocking long-shore sediment transport as illustrated in Figure 3.8.

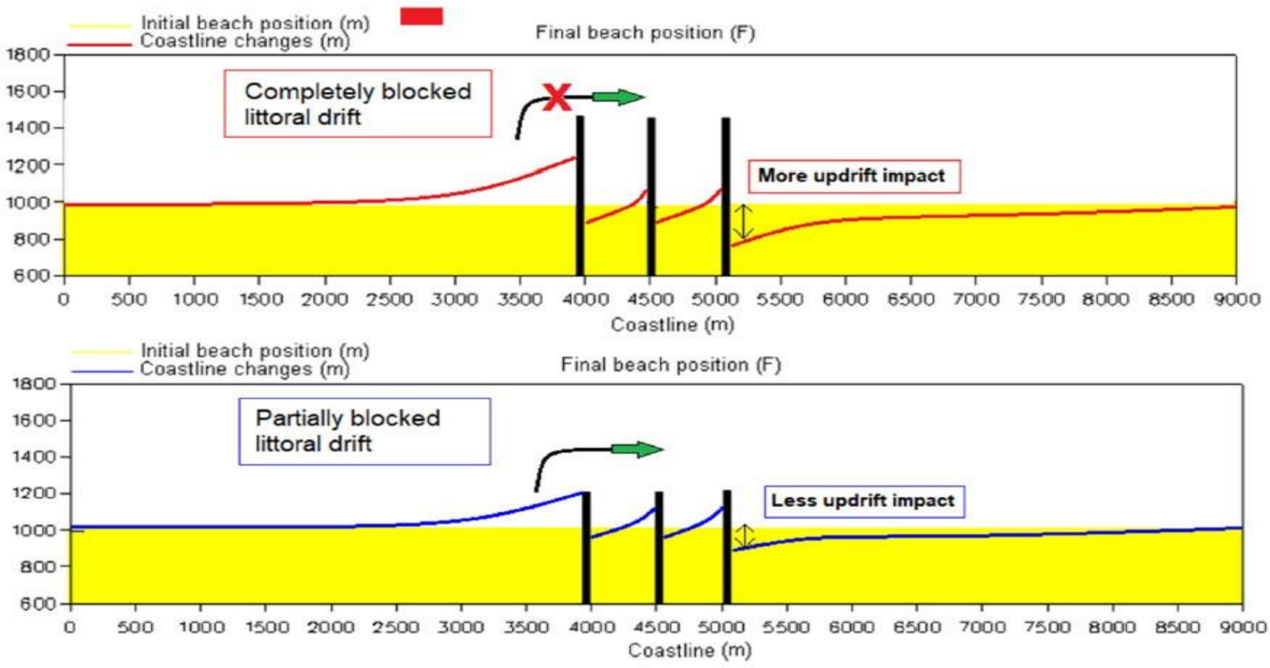


Figure 3.8: Schematic illustration of a long and short groyne field and their impact on the littoral drift regime and the adjacent coastline if not complimented with a beach nourishment programme (DHI, 2017)

3.3.1.4 Detached Breakwaters

Description

Detached breakwaters are almost always built as rubble-mound structures and are usually constructed parallel to the shoreline either inside or outside of the surf zone as illustrated in Figure 3.10. These defences provide shelter from waves, whereby the sediment drift behind the breakwater is decreased and the transport pattern adjacent to the breakwater is modified.

Depending on the physical characteristics of the breakwater and the proximity of the structure to the coastline, breakwaters can result in the formation of salients or tombolos. In both instances, there is an accumulation of sand between the breakwater and coastline, but with tombolos the accumulation of sand will create an emerged beach between the breakwater and coast as summarised in Figure 3.9 below.

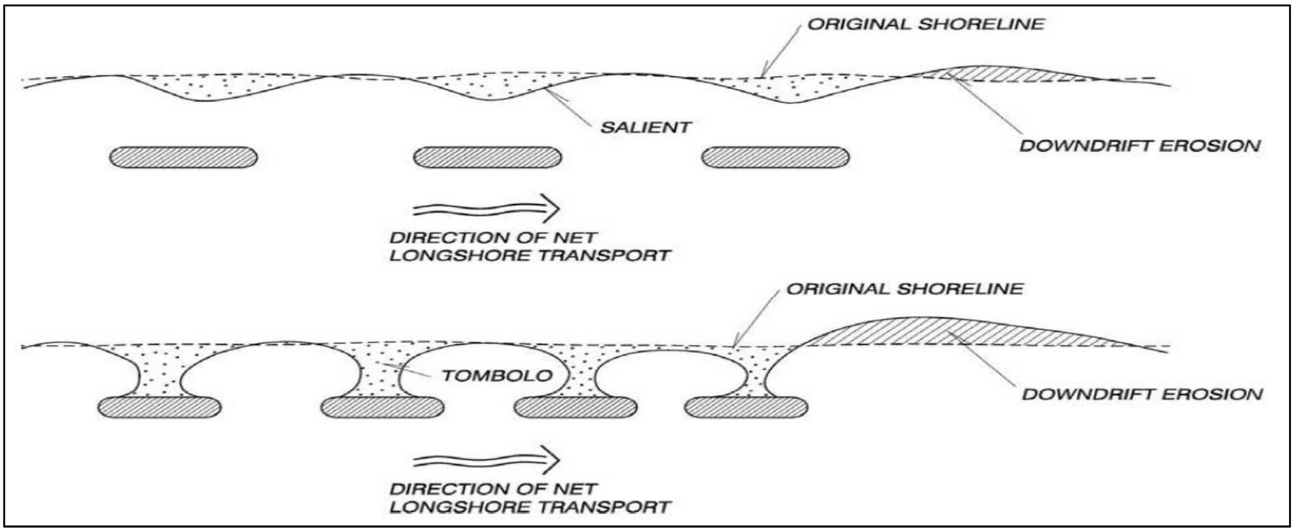


Figure 3.9: Typical beach configurations with detached nearshore breakwaters (USACE U.S. Army Corps of Engineers 2006).

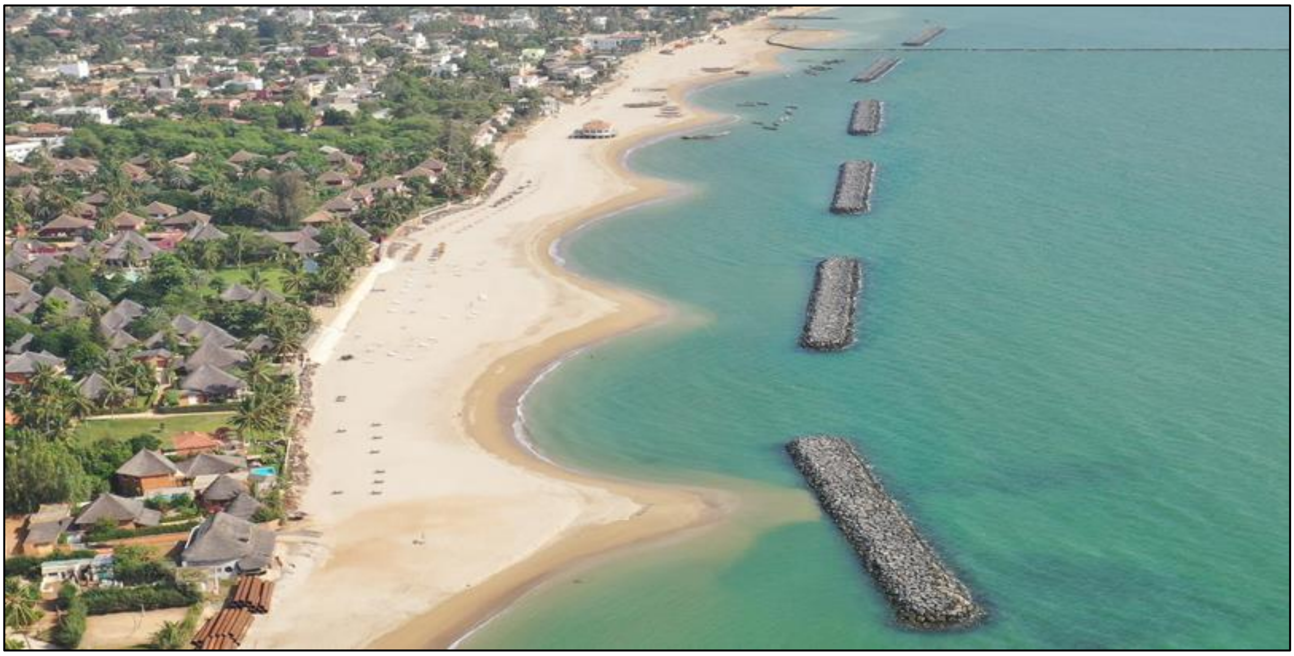


Figure 3.10: Example of offshore breakwaters with salient and tombolo formations.

Initial Appraisal

The environmental impact of breakwaters is highly variable and dependent on the size and location of the structure in relation to the coastline and beach profile. Breakwaters generally have an advantage over groynes in they do not obstruct access along the beach, however the accumulation of sand around the breakwater can be difficult to predict. Therefore, without a detailed assessment which often includes physical model testing it is difficult to assess the performance and environmental impact of a breakwater.

Breakwaters tend to work best along straight coastlines which have a dominant wave direction. The coastline along the Curran Strand is convex and therefore unlikely to be suitable for a breakwater. It should be noted that the beach in this region is convex partially because of the Skerries which act as an offshore breakwater.

As the Curran Strand is very popular for open water recreational activities, particularly surfing, a breakwater could create significant health and safety risks.

Given these complexities, it would be difficult to ensure a breakwater solution would mitigate the risks associated with coastal erosion without adversely impacting the existing coastal processes or creating unnecessary health and safety risks. .

Feasibility

This option should not be considered further for the following reasons:

- An offshore breakwater is very expensive to construct and maintain relative to other coastal management options.
- The convex shape of the Curran Strand would likely limit the effectiveness of an offshore breakwater.
- An offshore breakwater could create significant health and safety risks.
- The footprint of this structure would fall directly within the Skerries and Causeway Special Area of Conservation.

3.3.1.5 Embankments

Description

Embankments are onshore structures with the principal function of protecting low-lying areas against flooding. These structures are usually built as a mound of fine materials like sand and clay with a gentle seaward slope that reduces wave run-up and the erosive effect of the waves. The surface of the embankment can be grassed or armoured by asphalt, stones, or concrete slabs.

In most instances, embankments are constructed well above the mean high water mark which means that the structure is often fronted by a low-lying coastal platform. On an eroding shoreline, where dunes form the natural protection of the low hinterland, an embankment can be coupled with the construction of hard coastal defences as summarised Figure 3.11 below. Revetments are generally the preferred hard defence however seawalls can also be used.

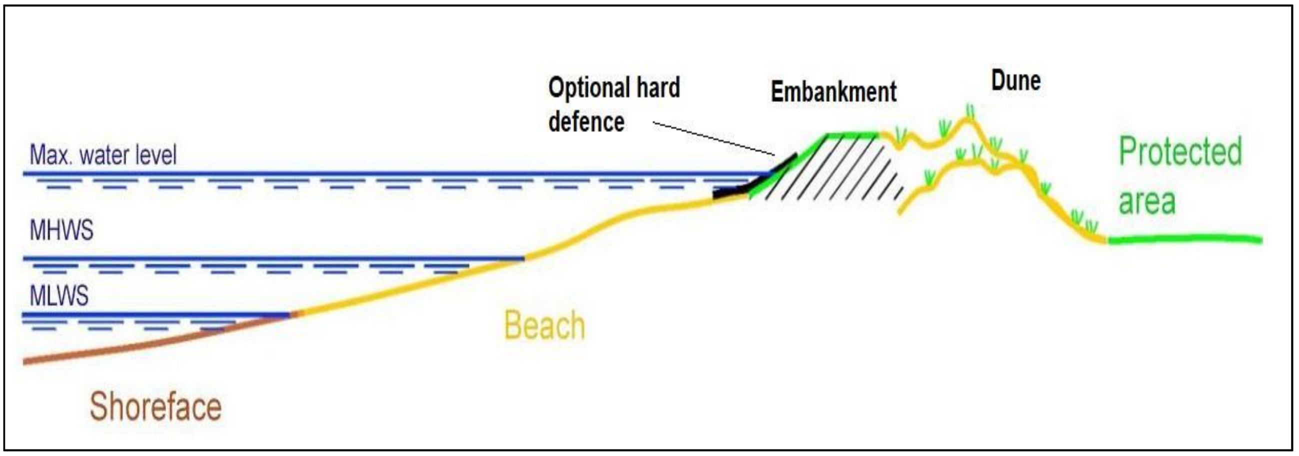


Figure 3.11: Typical section of an embankment with an optional hard defence on a sandy dune system (DHI 2017).

Initial Appraisal & Feasibility

The main function of an embankment is to prevent the flooding of a low coastal hinterland. As such, embankments are not considered a feasible option for this study as the primary risk at the 6th tee is that of coastal erosion.

3.3.1.6 Beach nourishment

Description

Beach nourishment is considered a *soft engineering* solution to managing coastal erosion. Nourishment material must be of similar size and density as the natural beach otherwise it can be easily removed and lost from a coastal system.

A re-nourished beach can reduce incident wave energy and mitigate the threat of erosion. Beach nourishment can also reduce the risk of coastal flooding from wave overtopping and act as a sediment source for areas down drift of the nourishment area.

Beach re-nourishment material can either be pumped ashore or sprayed in a suspended form from a barge vessel as illustrated in Figure 3.13. Both options tend to produce large volumes of suspended sediment in within the water column which can result in environmental impacts.

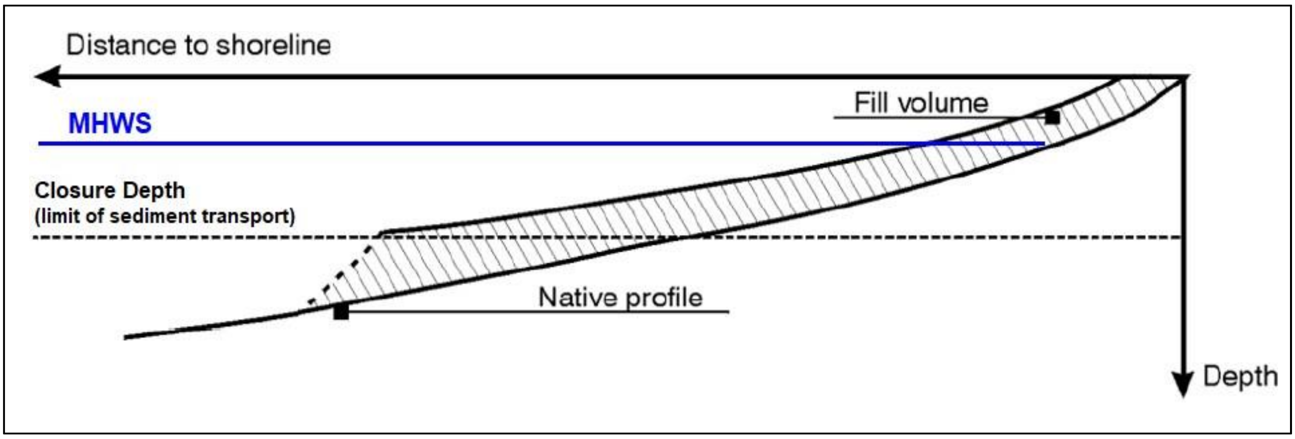


Figure 3.12: Typical section of a re-nourished beach profile (USACE U.S. Army Corps of Engineers 2006)

Figure 3.13: Beach nourishment material being placed onshore using a rainbow spray technique

Initial Appraisal

It is important to recognise that beach nourishment does not eliminate the cause of erosion which will continue to occur along the nourished beach section. This means that nourishment as a stand-alone method to mitigate coastal erosion requires a long-term maintenance effort. Alternatively, the success of a re-nourishment scheme can be enhanced with the construction of hard defences to limit the loss of sand.

The success of any nourishment scheme is dependent on the availability and suitability of the nourishment material. The specification of the nourishment material such as the grain size is crucial in determining the overall shape of the coastal profile. In most instances the volume of sand needed to re-nourish a profile increases drastically with decreasing grain size. On the contrary, coarser sand tends to be more stable in terms of longshore sediment losses.

Despite several countries within Europe including Belgium, Netherlands and Great Britain having long-established practices of marine aggregate extraction for the purposes of beach nourishment (amongst others), Northern Ireland or Ireland does not an established offshore dredging industry. As such, sourcing suitable material and obtaining the relevant permissions etc. could prove problematic and potentially costly.

Feasibility

This option should not be considered further for the following reasons:

- Beach nourishment can effectively mitigate erosion but benefits can be short-lived depending on the extent and scale of nourishment operation. Whilst effective protection may be afforded during a single event, the coastline could be left vulnerable during any successive storm event.
- There is no established offshore dredging industry in Northern Ireland. Nourishment material would therefore have to be sourced from a licensed aggregate site such as Liverpool Bay. This could present significant logistical challenges.
- To ensure that effective protection is afforded to the 6th, it would be necessary to re-nourish most of the Curran Strand, otherwise nourishment material could be transported from the 6th tee by longshore or cross-shore processes. Otherwise, sediment control structures such as groynes etc would be required to hold nourishment material within the vicinity of the 6th tee.
- Based on recent experience, mobilisation costs for beach nourishment schemes are in excess of £2million with the supply of material costing *c.* £20 per m^3. A suitable scheme for the Curran Strand could therefore cost *c.* £5million subject to the extent and scale of the project.

The possibility of using sand lost from the Curran Strand following extreme storm events to replenish the beach profile was discussed during previous consultation. Whilst it would be technically feasible to dredge material from a nearshore sand bar and pump it ashore, the logistics of commissioning a dredging operation would be impracticable and extremely costly.

3.3.1.7 Perched beach

Description

As illustrated in Figure 3.14 below, a perched beach is retained at an otherwise normal profile level by a submerged structure parallel to the coast. The submerged sill is usually constructed using rock armoured mound structures or commercially available pre-fabricated units.

Initial Appraisal

In principle, a perched beach is a simple concept in that the submerged sill structure prevents sand from moving offshore during active wave conditions. However, high waves combined with low tides can result in waves breaking over the sill. This can create strong undertow currents that lead to the permanent loss of sand material over the sill.

The concept of a perched beach is most applicable to coastal environments with steep and eroded coastal profiles. On the contrary, perched beaches are not well suited for coasts with oblique wave attacks and at locations with large tidal regimes.

From a public safety perspective, strong undertow currents at the sill structure can present a significant non-visible hazard to bathers.

Feasibility

This option should not be considered further for the following reasons:

- A perched beach is unlikely to retain an increased beach profile due to the variable nature of the wave climate at the 6th tee. Longshore sediment transport processes are also likely to reduce the effectiveness of this option.
- This option could create significant public health and safety risks, particularly to surfers.
- The footprint of this structure would fall directly within the Skerries and Causeway Special Area of Conservation.

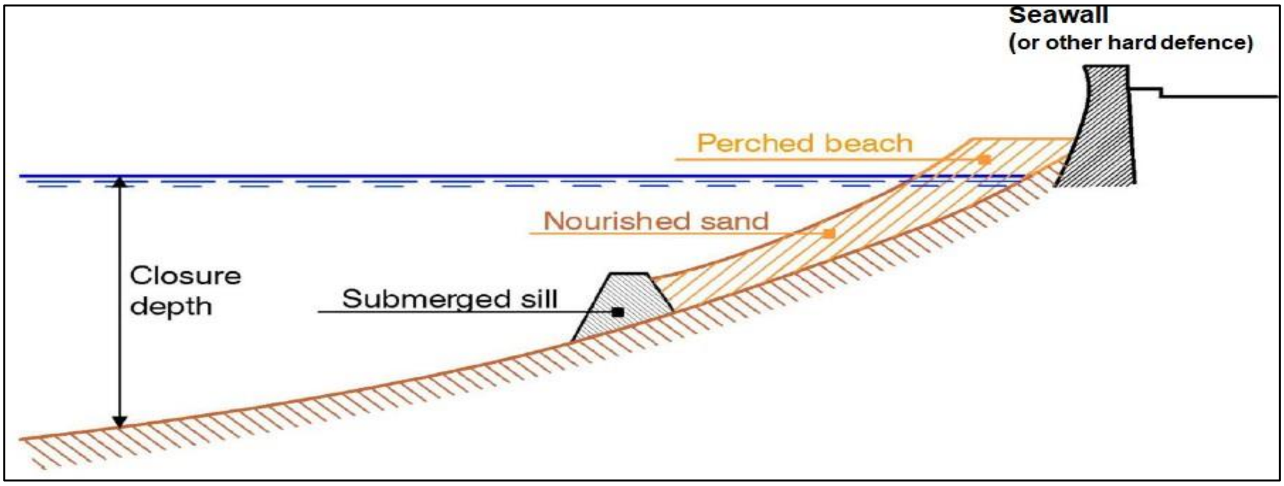


Figure 3.14: A typical section of a perched beach consisting of a beach fill supported by a submerged sill (DHI 2017)

3.3.1.8 Dune stabilisation

Description

Dune stabilisation is a collection of *soft engineering* methods aimed at protecting, preserving and enhancing the natural protection afforded by a beach and its dune systems. These methods include the construction of sand trap fencing, planting of marram grass and re-grading steep dune faces as shown in Figure 3.16

Dune re-profiling

- Where dune faces have become over-steepened through toe erosion or through a continual lowering of beach levels it can be difficult to acquire and retain a reasonable vegetation cover. Steep dunes will be continuously vulnerable to undercutting by wave action; resulting in failure and slumping of the upper dune face as illustrated in Figure 3.15.

  Re-profiling the dune to a more stable slope angle (usually around 1 in 2.5) will reduce the extent of damage caused if the toe of the dune is eroded by wave action. Re-profiling will initially allow the re-establishment of marram grass that will help stabilise a vulnerable dune face. Very quickly many plant and animal communities will become established in the dune and add considerably to the stability of the system.

  Whether a system is accreting or depleting, dune re-profiling will typically involve a significant reduction in the dune height.

  The success of dune re-profiling can be enhanced by the planting of marram, seeding, sand trap fencing or preferably a combination of all three. The aim of adopting these dune stabilisation techniques is to build up the foredune overtime before an extreme event. The built-up foredune can then act as a reservoir to feed sand onto the beach during future extreme storm events. Where erosion is active, this buffer provides a short-term defence to assets behind the dunes, possibly only lasting through a single storm event.

Figure 3.15: Example of over-steepened and unstable dune face at Portrane, Fingal.

Sand trap fencing

- Fencing traps wind-blown sand and facilitates the natural build-up of dunes. Vulnerable fore dunes can also be protected by encouraging the seasonal development of embryo dunes using sand trap fencing.

  There is scope for sand-trap fencing anywhere that across-shore aeolian sand movement occurs. Fencing can trap and disperse sand seasonally or lead to a long-term build-up. In both cases, there is a beneficial effect. The sand built up and dissipated seasonally becomes part of the active transport system that plays a fundamental role in coastal protection. Sand accumulated over the long-term remains available to the sand transport system for the future.

  Vulnerable dunes can be protected by encouraging the seasonal development of embryo dunes using sand trap fencing. Although they will be swept aside by winter seas a useful measure of protection will nonetheless have been afforded to the foredune.

  An example of a sand trap fencing solution at a beach in Co. Clare is illustrated in Figure 3.16.

Figure 3.16: Sand trap fencing at a beach in Co. Clare

Marram grass planting

Marram grass (*Ammophila arenaria*) can trap and stabilise significant volumes of sand in the right environment. Furthermore, the species tends to grow more vigorously with increased availability. Although basic to the dune building process marram does not grow naturally as a monoculture but is associated with many other plant species. Ideally, marram grass should therefore be planted with other dune-building species such as sand couchgrass (*Elynus farctus*) and lyme grass (*Leymus arenarius*).

As previously discussed, marram grass should ideally be used in combination with other soft engineering practices, principally dune re-profiling and sand trap fencing as illustrated in Figure 3.17.

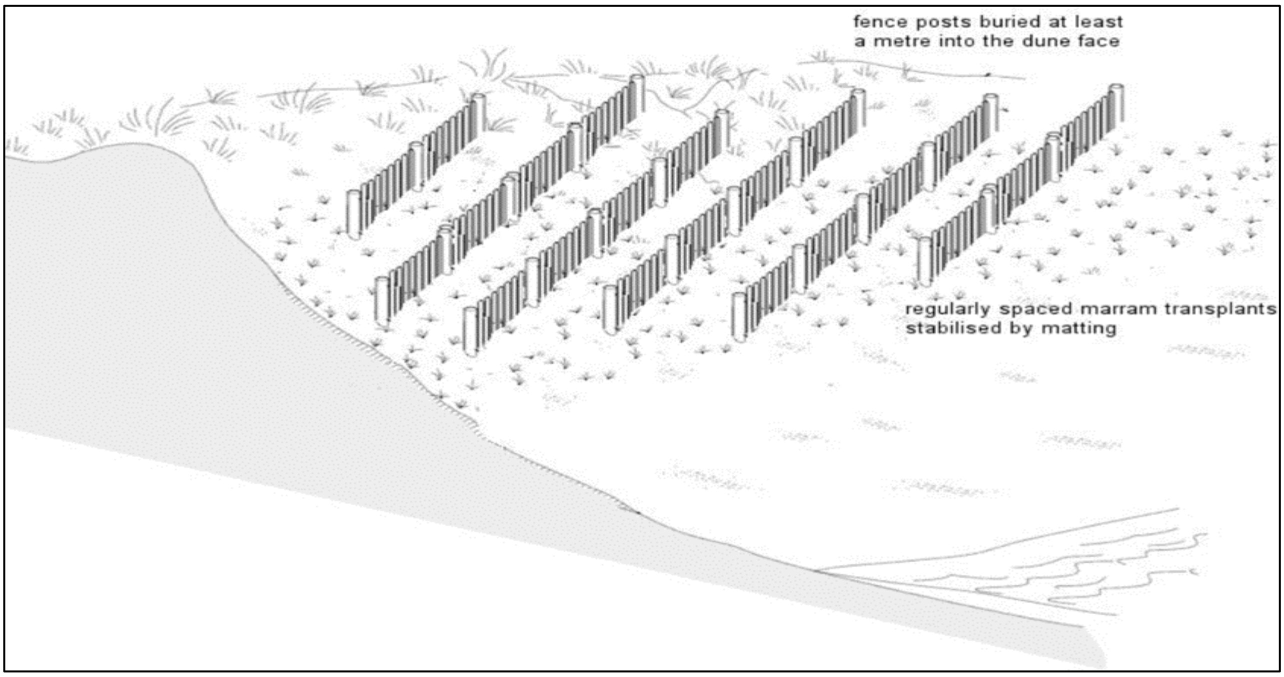


Figure 3.17: Typical section of a re-profiled dune face stabilised with sand trap fencing and the planting of marram grass

Initial Appraisal

It is a well-established fact that soft engineering measures can be effective in managing coastal erosion. These measures have been extensively used to re-build dune systems on the east coast of Scotland, and in some cases to build dunes over 30m high.

However, it is important to recognise that the natural protection afforded by the built-up dune system along energetic coastlines like the Curran Strand will be sacrificial and potentially very short-lived. Whilst these measures may protect a coastline during an individual event, important receptors such as the 6th tee can be left vulnerable to other storm events that may occur in quick succession.

Feasibility

This collection of soft engineering options should be considered further for the following reasons:

- These measures can provide effective, albeit potentially short-lived protection against wave-induced coastal erosion.
- These measures work with the natural environment to promote the growth of a dune system, with a relatively low impact on existing coastal processes.
- The sacrificial nature of these measures means that they will likely need to be repaired or replaced after extreme storm events.
- It can be difficult identifying suitable locations from which existing sprigs of marram grass and other suitable species can be extracted from without impacting other habitats.
- Whilst soft engineering measures could not be relied upon to prevent erosion of the 6th tee during extreme storms alone, they can be used to supplement other coastal management options.

3.4 Outcome of the Preliminary Options Appraisal

RPS undertook an appraisal of the long list of coastal management options described in Section 3.3 based on the primary objectives and critical success factors described in Section 3.1. In general, this considered the technical effectiveness, environmental & social impact, and economic viability of each option at a high level.

In addition to the high level policies of "Managed realignment" and "Managed retreat", the only "hold the line" options that were considered feasible to mitigate the risk of erosion at the 6th tee were the modified revetment and soft engineering options.

Whilst it is not possible to model the performance or impact of soft engineering measures, numerical models can be used to assess the performance of hard defence structures including revetment structures. To this end, various modified revetment options have been considered in the following Section of this report. The output of this assessment was used to inform the preferred coastal management plan for the 6th tee as described in Section 3.6.

Table 3.4: Summary of the "hold the line" coastal management options appraisal for the Curran Strand

Objective / Option	Prevent erosion of the 6th tee	Minimal impact on natural environment / coastal processes	Easily adaptable to climate change	Financially Feasible	Brought forward
No Active Intervention	✗	✓	✓	✗	✗
Seawalls	✓	✗	✗	✗	✗
Revetment / modified revetment	✓	✓	✓	✓	✓
Groynes	✗	✗	▲	✗	✗
Detached Breakwaters	▲	✗	✗	✗	✗
Embankments	✗	✓	✓	✓	✗
Beach Nourishment	✓	✓	✓	✗	✗
Perched Beach	▲	▲	✗	✗	✗
Soft Engineering	▲	✓	✓	✓	✓

Key	
Achieves objective	✓
Partially achieves objective	▲
Does not achieve objective	✗

3.5 Assessment of modified revetment options

3.5.1 Background

It has already been established in this report and others (RPS 2018) that modifying and properly terminating the existing revetment would reduce terminal erosion and mitigate the significant risk of coastal erosion to the iconic 6th tee of the Dunluce Links Championship course.

Previous work undertaken by RPS demonstrated that extending the existing revetment structure to include a 20m revetment would reduce terminal erosion and provide critical protection to the 6th tee during an extreme 1 in 100 year event. Further assessment concluded that a 20m rock revetment taper would result in no significant impact on the existing tidal regime, wave climate or sediment transport regime along the Curran Strand and wider area, including the Skerries and Causeway SAC.

DAERA Marine and Licensing Division has recommended consideration of the performance of an option whereby a portion of the existing 90m rock revetment is removed to better terminate the existing defence.

In response to this recommendation, RPS re-iterated that the dune at the 6th had already been demonstrated to be vulnerable to erosion during a 1 in 100 year event, thus reducing the effectiveness of the existing defence by introducing a taper would increase the existing risk of erosion to the 6th tee.

Notwithstanding this unchallenged evidential context, DAERA has continued to recommend following the grant of planning permission for EIA development LA01/2021/0822/F that RPGC model the performance of reducing the existing revetment.

3.5.2 Numerical assessment of revetment options

To address this recommendation, RPS used the same morphological modelling system and approach as described in the Environmental Statement that accompanied LA01/2021/0822/F (RPS 2018) to assess and quantify the impact of a 1 in 100 year return period storm event with:

1. The existing 90m defence in place
2. A modified version of the existing revetment, with 20m removed at the western flank to facilitate a taper.
3. The existing 90m defence with an additional 20m tapering revetment at the western flank.

The system used for this assessment was XBeach; a 2D morphological model developed to represent the natural response of a shoreline to time-varying storm conditions, including dune erosion, overwash and breaching. The model computes the propagation of waves, the non-stationary shallow water equations, sediment transport and avalanching to compute dune erosion and cross-shore transport.

XBeach has been validated with a series of analytical and field test cases and has been demonstrated to perform well in different situations including dune erosion, overwash and breaching

The XBeach model was developed to compute nearshore processes at the Curran Strand and therefore only extends seawards for *c*. 1km towards The Skerries, as illustrated in Figure 3.18. To optimise the computational efficiency and model accuracy, the resolution of the model grid was varied across the model entire domain. At the beach dune interface, the grid had a maximum size of 60m^2 and a minimum of 10m^2 in the region of the large dune and existing rock armour revetment. Along the y-axis, the grid size varied from 10m^2 to 850m^2 at the model boundary. The model was also set up to include a non-erodible hard layer at the base of the vulnerable dune to represent the various rock armour options described above.

The extreme 1 in 100-year boundary conditions for the model simulations were derived from an Extreme Value Analyses and Spectral Wave simulations as described in full in (RPS 2018).

The two-dimensional bed level change for all three options following the extreme storm event is illustrated in Figure 3.19. To illustrate the effect of each option more clearly, Figure 3.20, Figure 3.21 and Figure show the initial bed level and final bed level change at the following locations respectively:

- 10m prior to the termination of the existing defence, i.e., close to where a reduced taper would finish (***Figure 3.20***)
- At the termination of the existing defence, i.e., where the current defence finishes (***Figure 3.21***)
- At 25m west the termination of the existing defence, i.e., just beyond where an extended taper would finish (***Figure 3.22***)

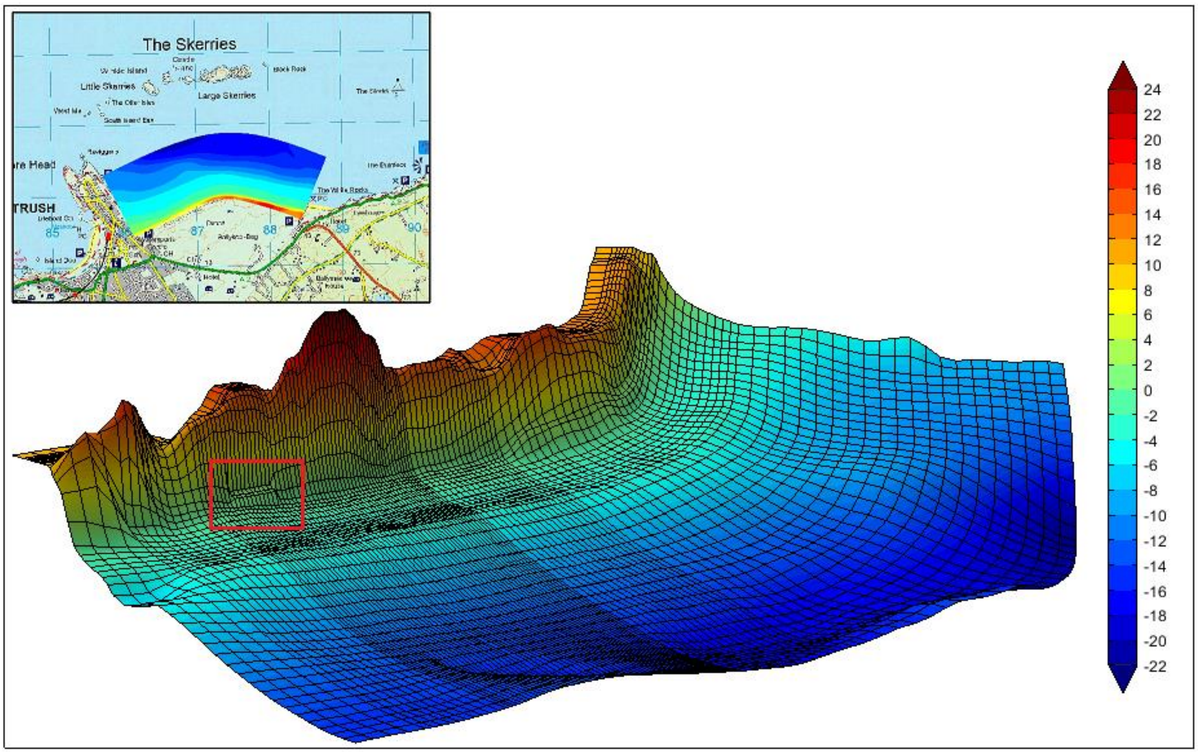


Figure 3.18: Extent and structure of the Curran Strand XBeach model. Location of revetment highlighted in red

An assessment of this information found that the existing 90m revetment only afforded partial protection to the 6th tee. Waves outflanking the western extent of the structure resulted in a localised retreat of the dune crest of c. 6m in the area of the 6th tee as illustrated in Figure 3.20 and Figure 3.21. Under this scenario, approximately 110m^2 of the Dunluce Championship course could be irreversibly lost to coastal erosion.

As illustrated in Figure 3.20, the option proposed by DEARA whereby the existing revetment is reduced by 20m to include a taper structure found that whilst erosion was reduced slightly, the dune crest in the area of the 6th tee remained at risk and retreated by a similar magnitude. Under this scenario, a localised section of the Dunluce Championship course would still be lost to coastal erosion. This is unsurprising given the length over which full-wave dissipation occurs is reduced by 20m.

The last option assessed was adding an additional 20m taper revetment to the existing structure to properly terminate the defence. As articulated in the Environmental Statement that formed part of planning permission LA01/2021/0822/F it was found that this option most effectively mitigated the risk of coastal erosion to the 6th tee during an extreme 1 in 100 year return period storm event as illustrated in Figure 3.22.

Importantly, it was found that adding a proper termination to the existing defence did not impact morphology or sediment transport beyond the immediate vicinity of the proposed taper structure as demonstrated by Figure 3.22 and that no impact was recorded throughout the wider domain as shown in Figure 3.19.

It can therefore be concluded that based on the extreme three-day 1 in 100-year storm scenario, the proposed 20m revetment resulted in a negligible impact on the existing sediment transport regime, the nearby offshore sandbanks or the wider sediment cell.

The results of this modelling exercise provide a robust demonstration that modifying the existing defence to include a reduced revetment and taper structure would not provide adequate erosion protection to the 6th tee.

Conversely, reducing terminal erosion by adding a 20m taper revetment was found to effectively mitigate this risk with a negligible impact on wider coastal processes.

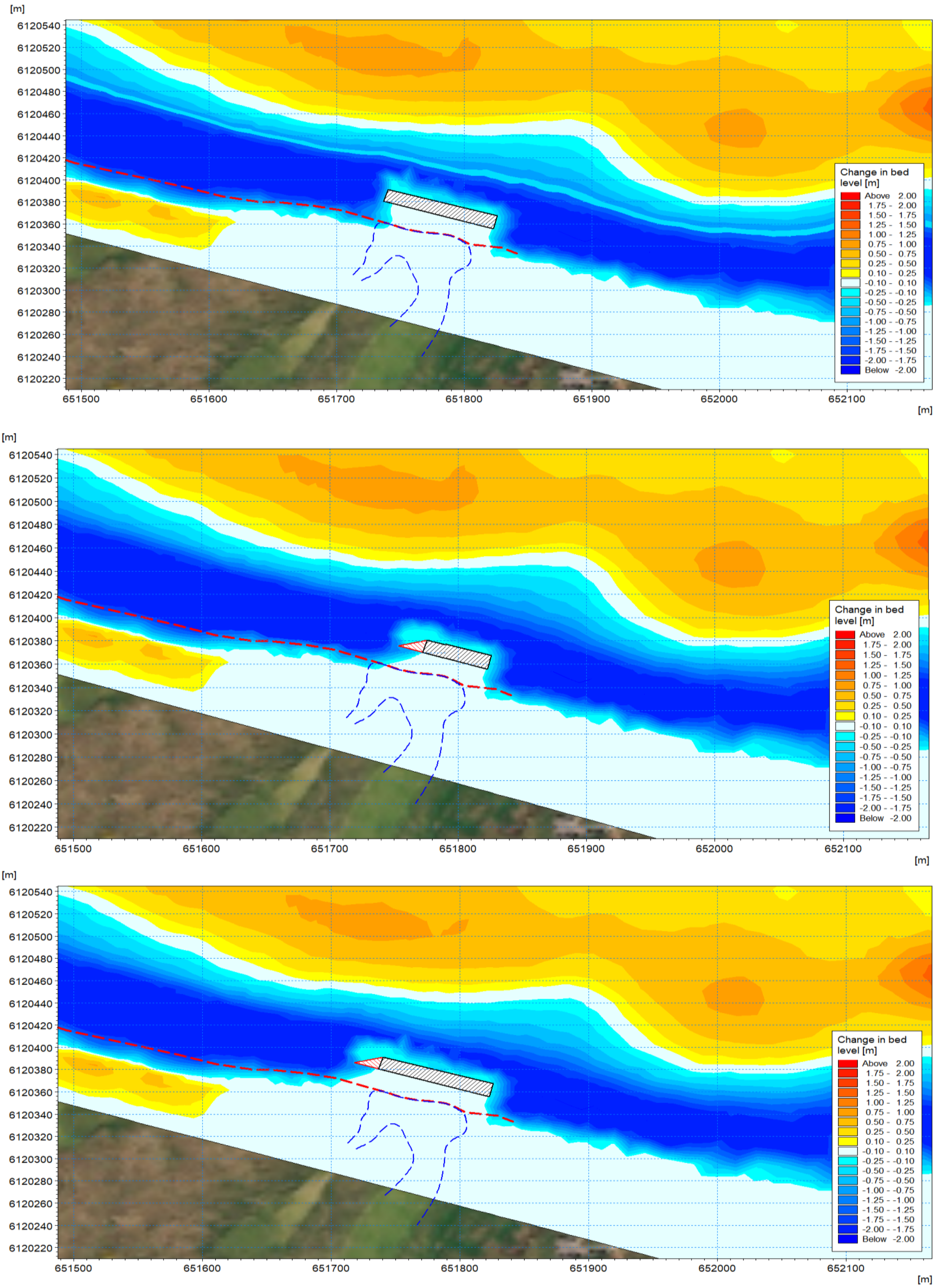
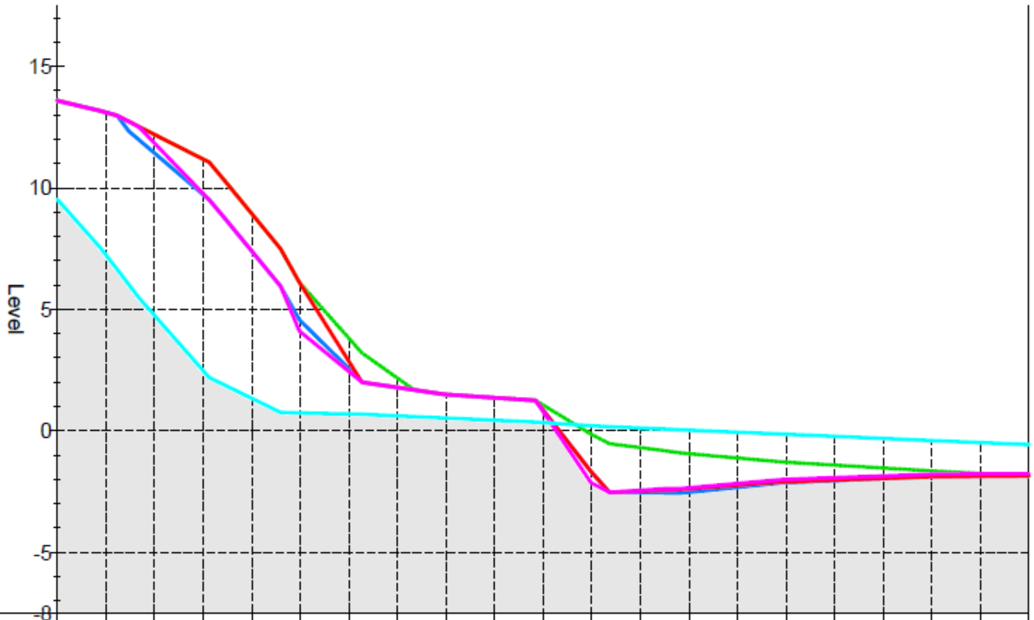
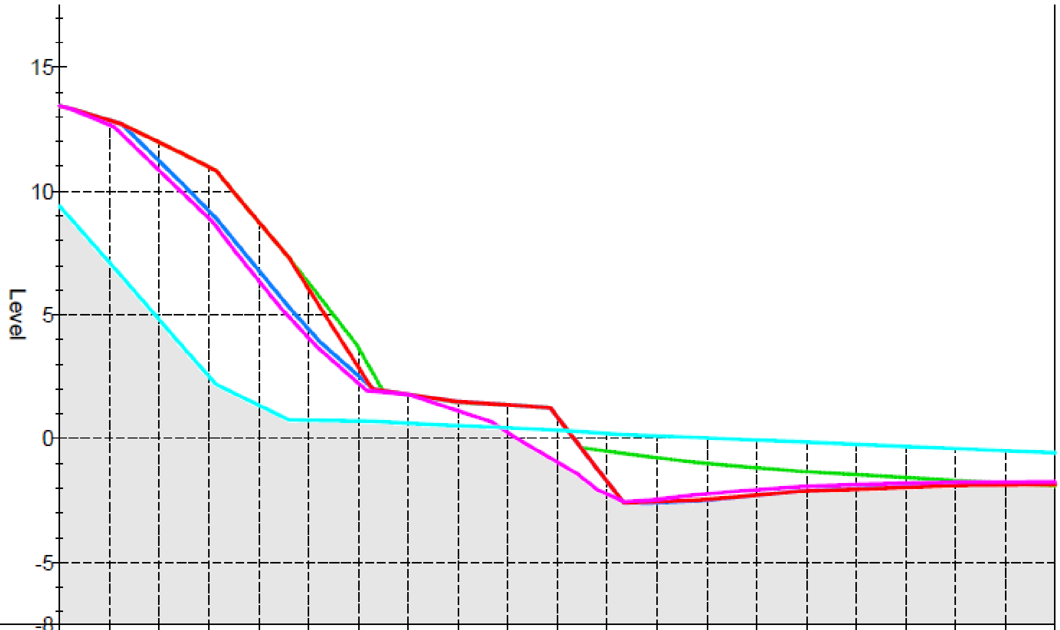


Figure 3.19: Bed level change at the 6th tee after a 1 in 100yr event with the existing revetment (top), a reduced revetment taper (middle) and extended revetment taper (bottom)



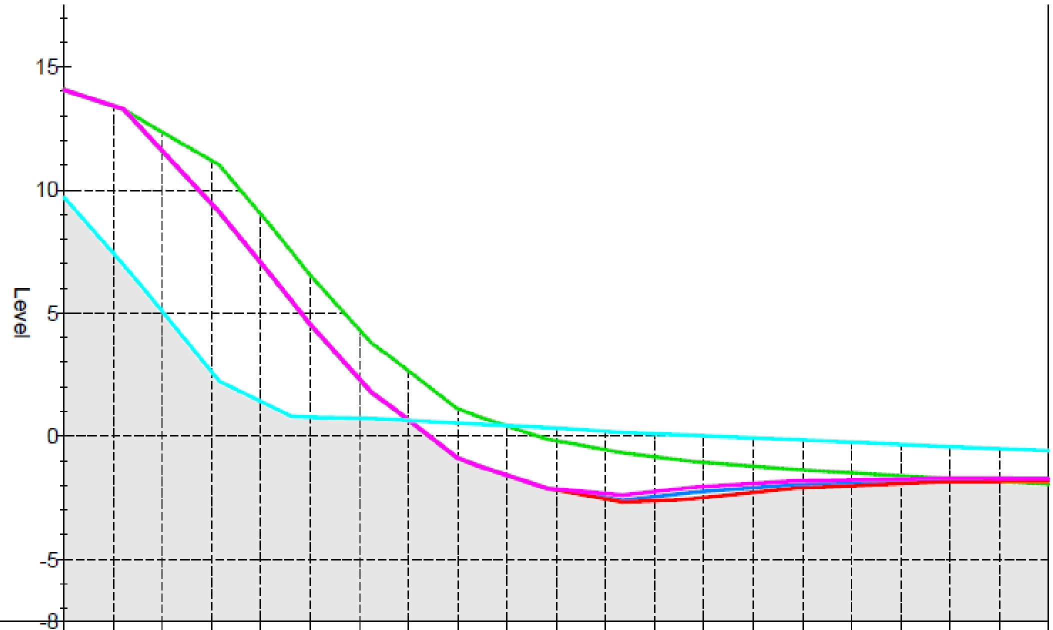
Reduced Defence Level	13.11	11.84	9.77	7.40	4.08	2.44	1.78	1.49	1.36	0.78	-2.15	-2.45	-2.35	-2.17	-2.00	-1.92	-1.86	-1.79	-1.77
Extended Defence Level	13.11	12.19	11.18	8.94	6.06	2.86	1.78	1.49	1.36	0.85	-1.72	-2.48	-2.39	-2.24	-2.09	-2.03	-1.96	-1.88	-1.87
Existing Defence Level	13.11	11.43	9.72	7.40	4.54	2.56	1.78	1.49	1.36	0.85	-1.72	-2.54	-2.53	-2.33	-2.14	-2.06	-1.97	-1.88	-1.86
No Defence Level	7.24	4.75	2.48	1.34	0.73	0.70	0.62	0.53	0.44	0.34	0.21	0.12	0.03	-0.06	-0.14	-0.23	-0.31	-0.40	-0.48
Initial Level	13.11	12.20	11.19	8.94	6.07	3.81	2.17	1.49	1.36	1.06	-0.15	-0.69	-0.94	-1.12	-1.29	-1.41	-1.53	-1.65	-1.76
Offset	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00	60.00	65.00	70.00	75.00	80.00	85.00	90.00	95.00

Figure 3.20: Bed level change across the dune system at *c.*10m prior to the termination of the existing defence following a three day, 1 in 100 year return period storm event with different defence options



Reduced Defence Level	12.67	10.83	8.90	6.38	4.06	2.23	1.79	1.13	0.25	-0.95	-2.24	-2.45	-2.23	-2.06	-1.93	-1.86	-1.80	-1.75	-1.74
Extended Defence Level	12.86	11.97	10.97	8.75	6.05	2.89	1.79	1.50	1.36	0.87	-1.74	-2.55	-2.45	-2.28	-2.12	-2.05	-1.97	-1.89	-1.87
Existing Defence Level	12.86	11.21	9.19	6.79	4.42	2.54	1.79	1.50	1.36	0.87	-1.74	-2.60	-2.48	-2.28	-2.10	-2.02	-1.94	-1.85	-1.83
No Defence Level	7.11	4.80	2.51	1.35	0.74	0.71	0.63	0.53	0.44	0.34	0.21	0.11	0.03	-0.06	-0.14	-0.23	-0.32	-0.40	-0.49
Initial Level	12.86	11.97	10.97	8.75	6.29	3.67	1.78	1.47	1.36	0.87	-0.51	-0.77	-1.00	-1.17	-1.33	-1.45	-1.57	-1.68	-1.79
Offset	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00	60.00	65.00	70.00	75.00	80.00	85.00	90.00	95.00

Figure 3.21: Bed level change across the dune system at the termination of the existing defence following a three day, 1 in 100 year return period storm event with different defence options



Offset	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00	60.00	65.00	70.00	75.00	80.00	85.00	90.00	95.00
Reduced Defence Level	13.41	11.57	9.43	7.03	4.54	2.32	0.65	-0.89	-1.59	-2.15	-2.33	-2.25	-2.05	-1.92	-1.81	-1.77	-1.73	-1.70	-1.71
Extended Defence Level	13.41	11.57	9.43	7.03	4.54	2.32	0.65	-0.89	-1.59	-2.19	-2.55	-2.62	-2.49	-2.28	-2.10	-2.02	-1.93	-1.85	-1.83
Existing Defence Level	13.41	11.57	9.43	7.03	4.54	2.32	0.65	-0.89	-1.59	-2.17	-2.49	-2.45	-2.25	-2.09	-1.96	-1.90	-1.83	-1.77	-1.76
No Defence Level	7.43	5.05	2.60	1.41	0.77	0.73	0.64	0.53	0.43	0.33	0.20	0.10	0.02	-0.07	-0.15	-0.24	-0.34	-0.43	-0.51
Initial Level	13.41	12.34	11.19	9.00	6.53	4.32	2.65	1.11	0.41	-0.19	-0.55	-0.84	-1.06	-1.22	-1.37	-1.49	-1.61	-1.73	-1.83

Figure 3.22: Bed level change across the dune system at 25m west the termination of the existing defence following a three day, 1 in 100 year return period storm event with different defence options

3.6 Identifying the preferred Coastal Change Management Plan

The options appraisal described in the previous Sections of this report identified the following coastal management policies and options to be feasible solutions to addressing either some or all aspects of the coastal erosion risk posed to the 6th tee of the Dunluce Championship course:

1. Managed realignment;
2. Managed retreat; and
3. Hold the line, specifically by:
    a. Reducing terminal erosion at the western flank of the existing rock armour by constructing an additional 20m tapering revetment structure consistent with planning permission LA01/2021/0822/F.
    b. Implementing a series of soft engineering measures comprising dune stabilisation, re-profiling, marram grass planting and sand trap fencing, consistent with planning permission LA01/2021/0822/F
    - *An option to create a taper structure by reducing the existing revetment was not considered feasible as it did not mitigate the risk to the main risk receptor, i.e., the 6th tee.*

Developing suitable and sustainable coastal management plans has always faced the challenge of decision-making in the face of multiple uncertainties, including in the climate, the economy and society. Traditionally, these have been addressed by adopting a precautionary approach, acting as early as possible to manage potential risks, but the costs associated with this approach can often be high.

Alternatively, an adaptive approach, which is more flexible and capable of addressing challenges and opportunities as they arise can offer significant technical, economic, social and environmental advantages. Benefits can include improved resilience to negative changes (e.g., sea level rise, increases in extreme weather) and enabling opportunities to arise from positive future changes (e.g., changes in coastal management strategy policy, improved scientific knowledge, funding increases).

In respect of managing the coastal erosion risk to the 6th tee, the predicted rise in future sea levels is perhaps the most important future consideration given the direct consequences such changes would have on tidal flows, wave heights and coastal erosion. Further information on this risk can be found in the next Section.

3.6.1 Future Climate Change

A Special Report on the Ocean and Cryosphere in a Changing Climate as prepared by the IPPC notes that there has been an accelerated rise in global mean sea levels (GMSL) in recent decades. This rise has been attributed to increasing rates of ice loss from the Greenland and Antarctic ice sheets as well as continued glacier mass loss and ocean thermal expansion. The IPCC noted that over the 21st century, the ocean is projected to transition to unprecedented conditions.

As summarised in Table 3.5, the Special Report prepared by the IPCC predicts a mean global sea-level rise of between 0.43m and 0.84m by 2100 depending on the future greenhouse gas emissions scenarios. The IPCC refer to these scenarios as Representative Concentration Pathways (RCPs). RCP 2.6 represents a scenario whereby greenhouse gas emissions are strongly reduced through high levels of mitigation whilst RCP 8.5 corresponds to the pathway with the highest greenhouse gas emissions and is often considered a "business as usual scenario".

Depending on future climate conditions the mean global rise in sea levels could increase to between 0.84m and 3.85m by 2300 as illustrated in Figure 3-23.

Table 3.5: Summary of future global mean sea level change by 2100 and 2300 (IPCC, 2019)

Scenario	RCP 2.6		RCP 8.5	
Year	Mean	Likely Range	Mean	Likely Range
2100	0.43m	0.29 – 0.59m	0.84m	0.61 – 1.10m
2300	0.84m	0.60 – 1.07m	3.85m	2.30 – 5.40m

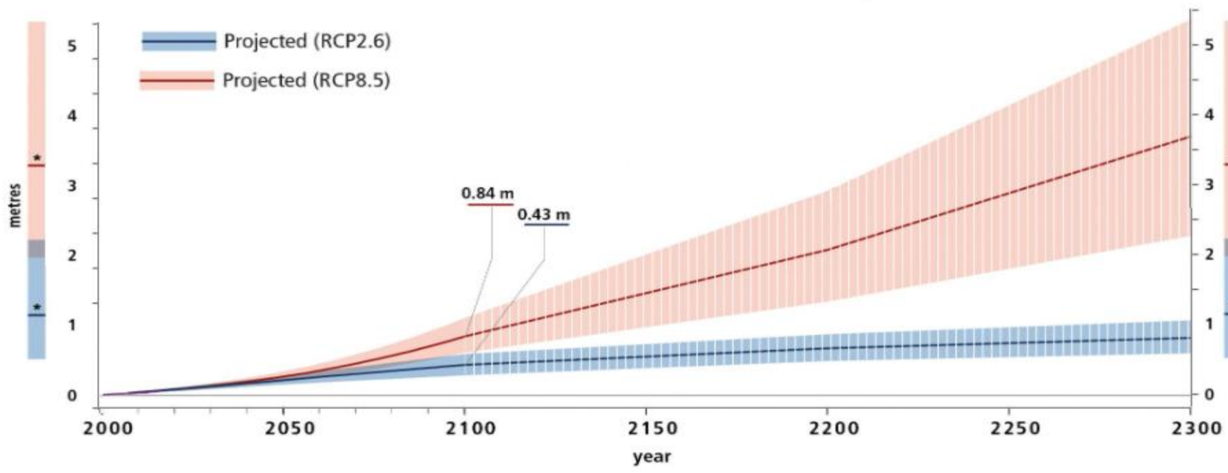


Figure 3-23: Global mean sea-level change with likely ranges for the RCP2.6 and RCP8.5 emissions scenario. Hashed shading reflects low confidence in sea-level projections (IPCC, 2019)

It is for these reasons that existing guidance (Environment Agency 2020) recommends that coastal management plans for vulnerable areas are appraised over the short, medium and long term for a 100-year period.

3.6.2 Draft Coastal Management Plan for Royal Portrush Golf Club

Cognisant of increased coastal pressure that will result from future climate change, RPS have developed a technically effective and environmentally and socially sustainable adaptive Coastal Management Plan to mitigate the risk of coastal erosion to the 6th tee over the short, medium and long term.

It has been demonstrated that a 1 in 100 year return period storm event could result in a localised retreat of the dune crest of c. 6m in the area of the 6th tee. Under this scenario, approximately 110m^2 of the Dunluce Championship course would be irreversibly lost to coastal erosion.

This is considered an unacceptable risk given the significant impact that such a loss would have on the internationally iconic Dunluce Championship course, investments made by both the NI Executive and the R&A and the impact on the regional tourism asset and economy.

Realigning the vulnerable sections of the Dunluce Championship course over the short term is not considered feasible owing to the time and investment required to develop an alternative course layout that preserves the character of the course and its future function. This process would require extensive input from course architects, the R&A and other relevant stakeholders.

To provide an effective safeguard over the **Short Term (2022 – 2042)**, RPS's modelling assessment has confirmed that the existing 90m defence structure should be properly finished by constructing an additional 20m tapering revetment to mitigate terminal erosion and the significant risk posed to the 6th tee. This will be supplemented with soft engineering measures, including dune re-profiling, planting of marram grass and sand trap fencing – all of which formed part of the proposal granted planning permission in May 2021 (LA01/2021/0822/F).

Reducing the existing revetment to create a taper is ineffective.

In combination, these measures are considered a contingency plan for an extreme storm event which has a 20% chance of occurring over the short term.

RCPG will continue to examine climate resilient management options for the medium to long term. This will be informed by the evidential baseline context relating to the dune lands adjacent to the Curran strand through ongoing monitoring work following the implementation of planning permission LA01/2021/0822/F.

4 CONCLUSION

Extensive studies have demonstrated that an extreme 1 in 100 year return period storm event could result in the dune system at the 6th tee of the Dunluce Championship Course retreating by *c.*6m. Under this scenario, approximately 110m^2 of the Dunluce Championship course could be irreversibly lost to coastal erosion, resulting in potentially significant impacts to the Northern Irish economy given the importance of the Royal Portrush links as a national tourism asset.

Through an extensive numerical modelling programme, RPS developed a modest 20m taper structure that could be constructed at the western extent of the existing 90m revetment structure. This proposal effectively mitigated the irreversible damage of coastal erosion and associated coastal retreat at the 6th tee. A planning application (LA01/2017/0539/F) for this proposal was submitted to the Causeway Coast and Glens Borough Council (CCGBC) and granted planning approval (*with conditions*) in May 2021.

In March 2022, Clyde Shanks on behalf of RPGC engaged with the Department of Agriculture, Environment and Rural Affairs (DAERA) Marine Licensing Team to discuss the contents of a Marine Licence application. During this process, the Department recommended the assessment of an option in which the existing 90m defence was modified and reduced to include a tapering structure.

To address this recommendation RPS has reviewed the comprehensive work undertaken as part of the Environmental Statement prepared as part of LA01/2017/0539/F, subsequently LA01/2021/0822/F (as approved 08th August 2022) and examined all alternative coastal management measures, including an option whereby the existing revetment structure is reduced by *c.*20m to facilitate a tapered revetment solution.

This optioneering process appraised a range of coastal management policies and options to develop a suitable and sustainable adaptive Coastal Management Plan over the short, medium and long term for a 100-year period. Cognisant of increased coastal pressure caused by future climate change, RPS developed the Coastal Management Plan summarised in Table 4.1 to mitigate the risk of erosion to the iconic 6th tee.

Table 4.1: Summary of the preferred Coastal Management Plan to protect the 6th tee of the Dunluce Championship course between the short and long term (2022 – 2122)

Management Period	Proposed Coastal Management Plan
Short Term (2022 – 2042)	The existing 90m defence structure should be properly finished by constructing an additional 20m tapering revetment to mitigate terminal erosion and **Hold the Line** at the 6th tee. This should be supplemented with soft engineering measures, including dune re-profiling, planting of marram grass and sand trap fencing. This will require timely implementation of planning permission LA01/2021/0822/F. Realigning the vulnerable sections of the Dunluce Championship course over the short term is not considered feasible owing to the time and investment required to develop an alternative course layout that preserves the character of the course and its future function. This process would require extensive input from course architects, the R&A and other relevant stakeholders. RPCG will continue to examine climate resilient management options for the medium to short term.
Medium to Long Term (2042 – 2022)	RPGC should maintain a monitoring regime post implementation of planning permission LA01/2021/0822/F and share the results of such activity with the Department. To this end, RPGC is committed to engaging with relevant stakeholders to fully understand and define baseline conditions and assess the future evolution of the coastline over the medium and long term.

References

Cooper, J.A.G, and O H Pilkey. 2004. “Society and sea level rise.” *Science* 303: 5665.

DHI. 2017. “Shoreline Management Guidelines.”

Environment Agency. 2020. “Flood and Coastal Defence Project Appraisal Guidance.”

HM Treasury. 2013. “The Green Book: appraisal and evaluation in central government.”

RPS. 2018. “Coastal Processes along the Curran Strand, Portrush.”

USACE U.S. Army Corps of Engineers. 2006. *Coastal engineering manual.*